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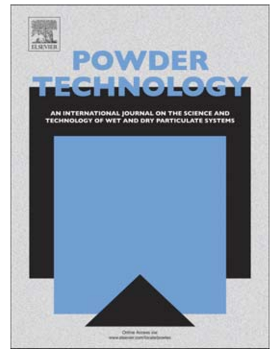

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Investigation of local heat transfer in random particle packings by a fully resolved LBM-approach

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Abstract

Static particle/fluid systems occur in a wide range of technical processes in chemical industry and in energy technology. Direct numerical simulations (DNS) can be applied to model the fluid flow in particle packings and thus to examine heat and momentum transfer in those systems. Besides traditional CFD simulations, the Lattice-Boltzmann method (LBM) has been established as an alternative and efficient approach. Thermal LBM (TLBM) relies on a set of two distribution functions which represent the fluid flow and its internal energy and cover convection-diffusion problems. In the present study a D3Q19 model with a multiple-relaxation-time (MRT) collision model for density distributions and a Bhatnagar–Gross–Krook (BGK) collision model for energy distributions is used. The fluid-solid boundaries are represented by interpolated bounce-back methods. Numerical investigations are performed for single sphere and random particle packings. Particle averaged and local heat transfer coefficients are considered. Obtained results are compared against available state of the art correlations and recent numerical results from the literature. The results demonstrate the accuracy of the derived LBM approach. Particle averaged and local heat transfer coefficients in sphere packings are presented in a range of $Re_p = 20 - 100$ and $\varepsilon = 0.6 - 1$. A correlation of local heat transfer coefficients in random sphere packings is derived.

Keywords: Direct numerical simulation (DNS); Lattice Boltzmann method (LBM); Particle packing; Convective heat transfer; Particle averaged heat transfer coefficient; Local heat transfer coefficient